



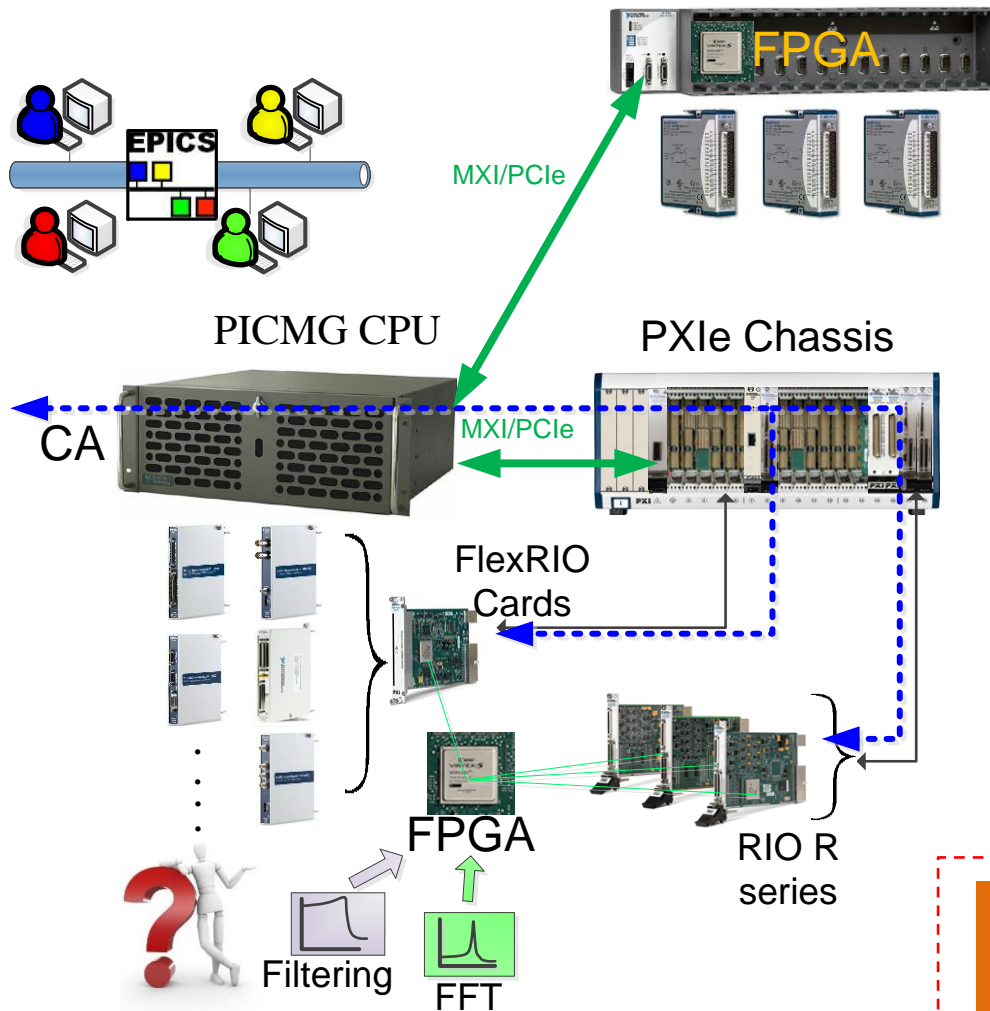
# IRIO TECHNOLOGY: DEVELOPING APPLICATIONS FOR ADVANCED DAQ SYSTEMS USING FPGAs

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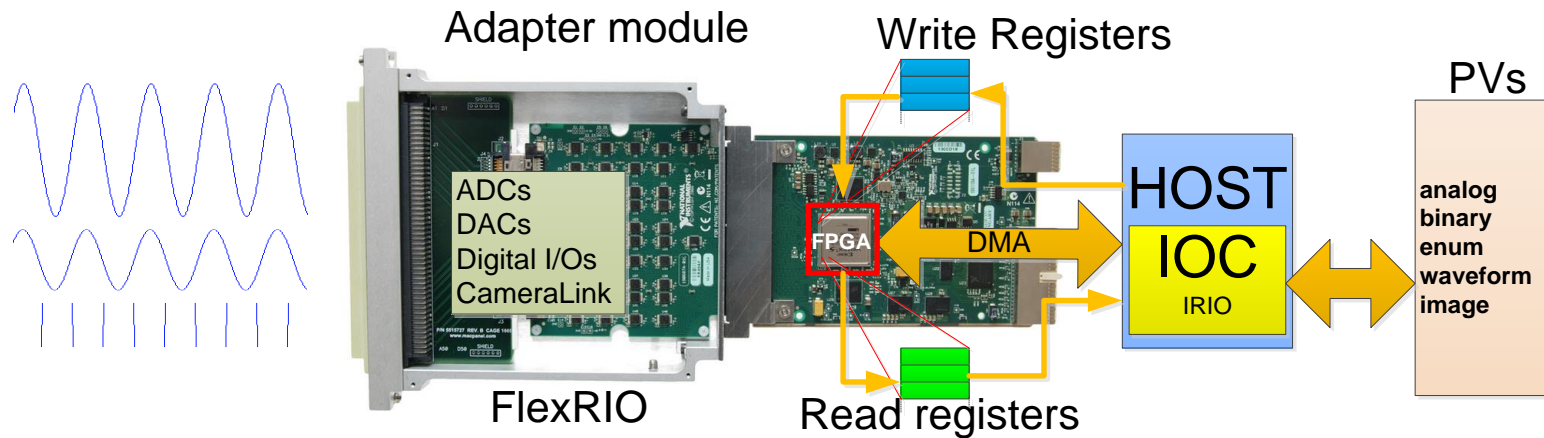
# Motivation



- FPGAs provide reconfigurable hardware with deterministic data preprocessing capabilities
- Graphical tools such as LabVIEW for FPGA reduces development and integration time
- The combination of both technologies with EPICS simplifies the development of complex control, data acquisition and processing systems

**IIRIO is a set of software tools simplifying the integration of RIO devices in EPICS**

# RIO/FlexRIO Devices



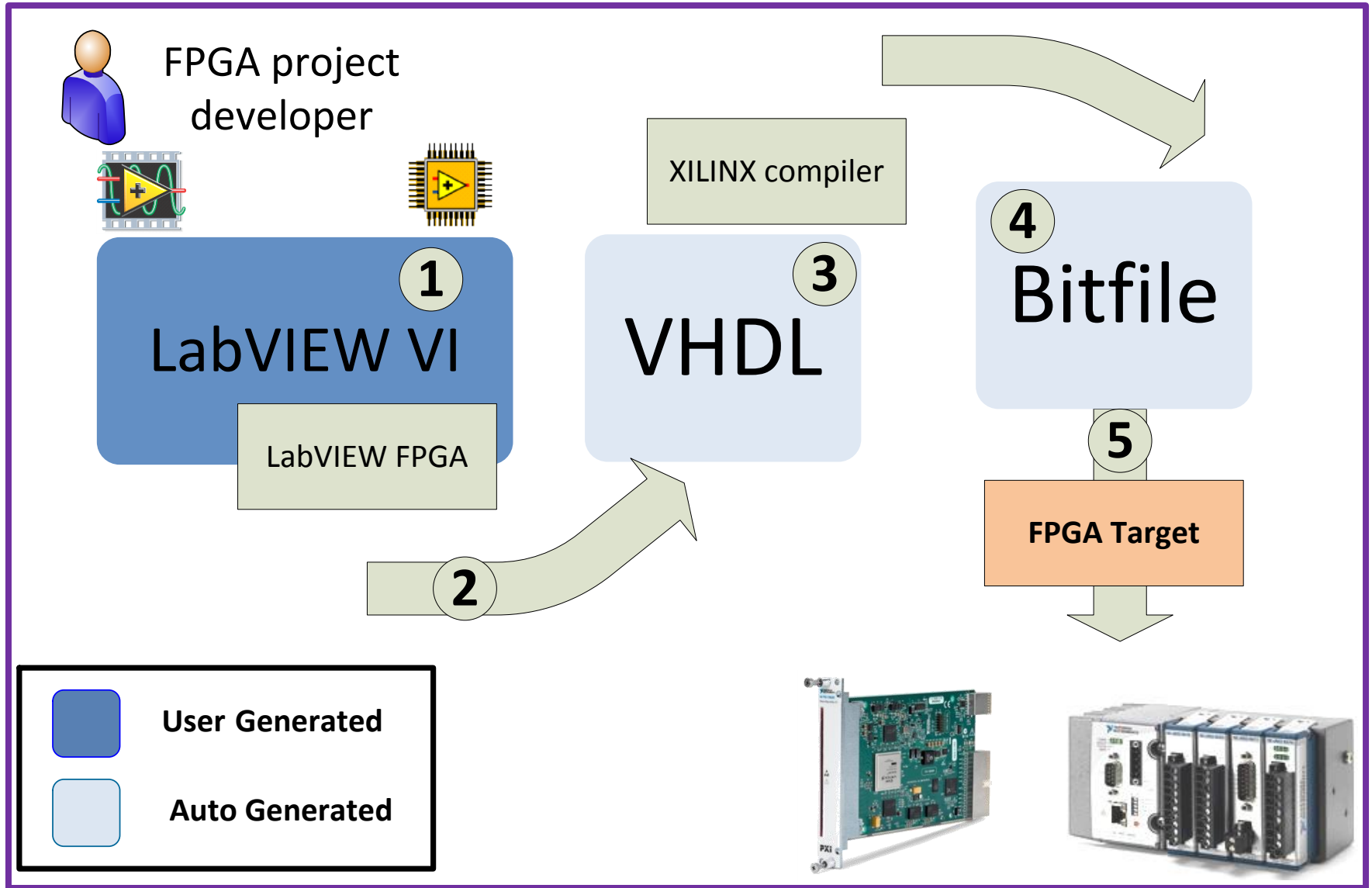
1

The developer defines the functionality programming the FPGA

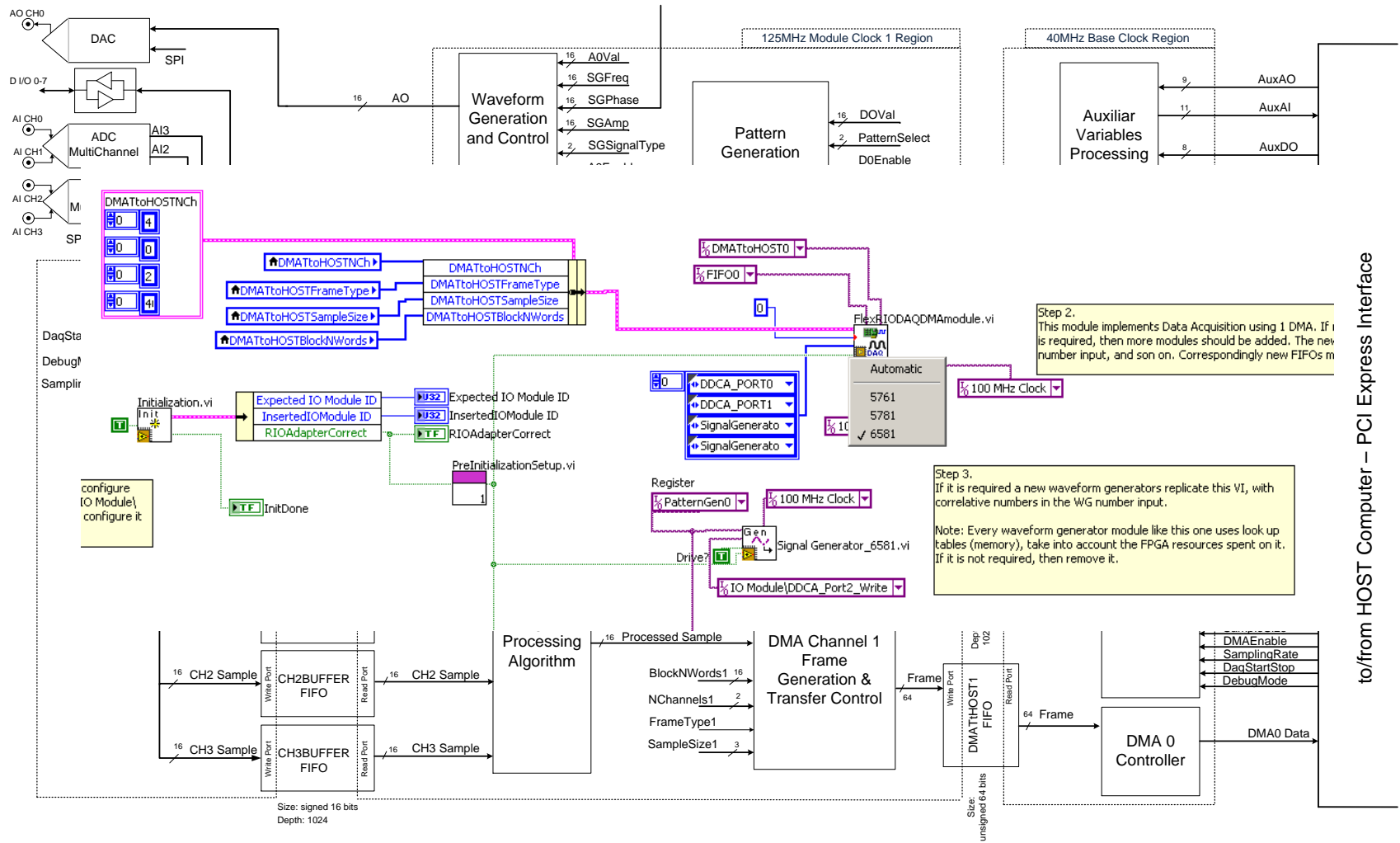
2

EPICS connects a user defined device with PVs for configuration and supervision

# Development cycle: LabVIEW for FPGA

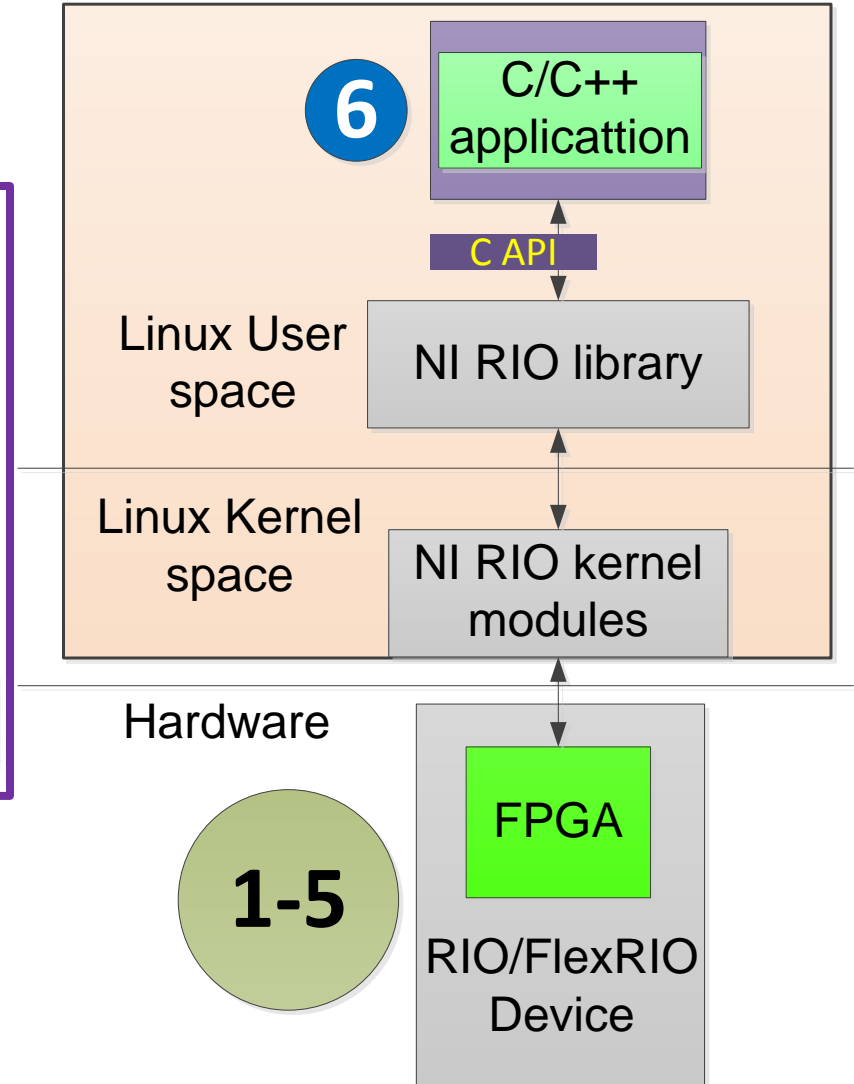
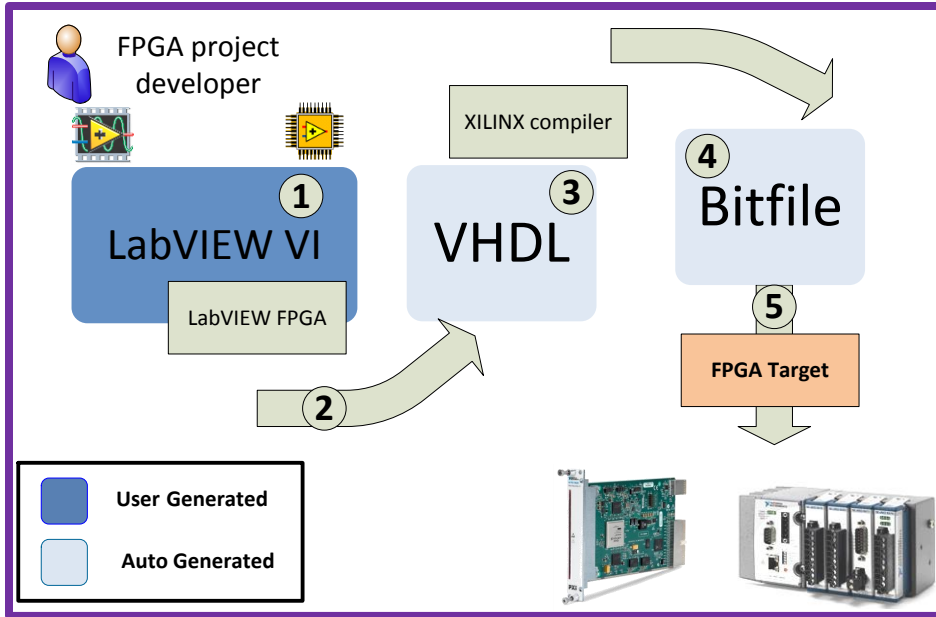


# Reducing development time in FPGAs using templates

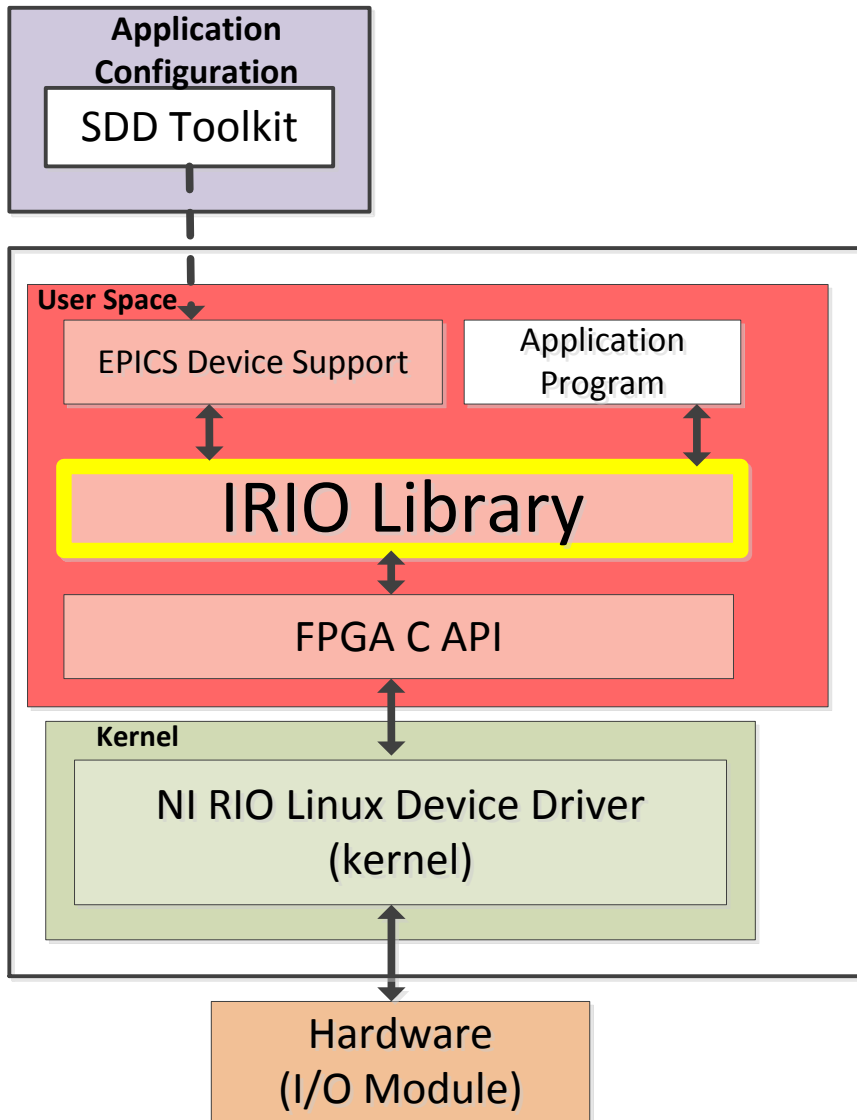


to/from HOST Computer – PCI Express Interface

# Using RIO devices in Linux



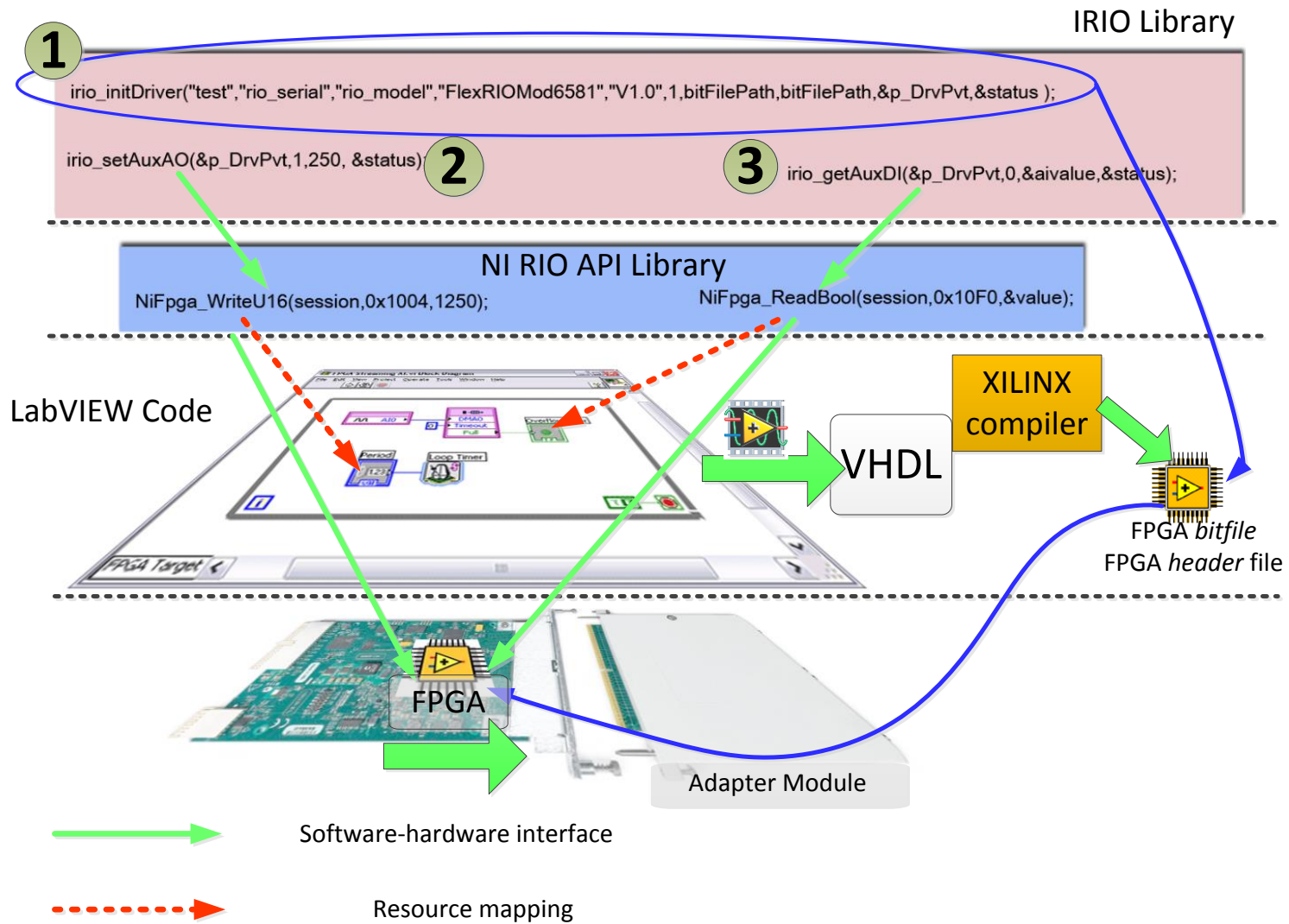
# IRIO Project: IRIO Library



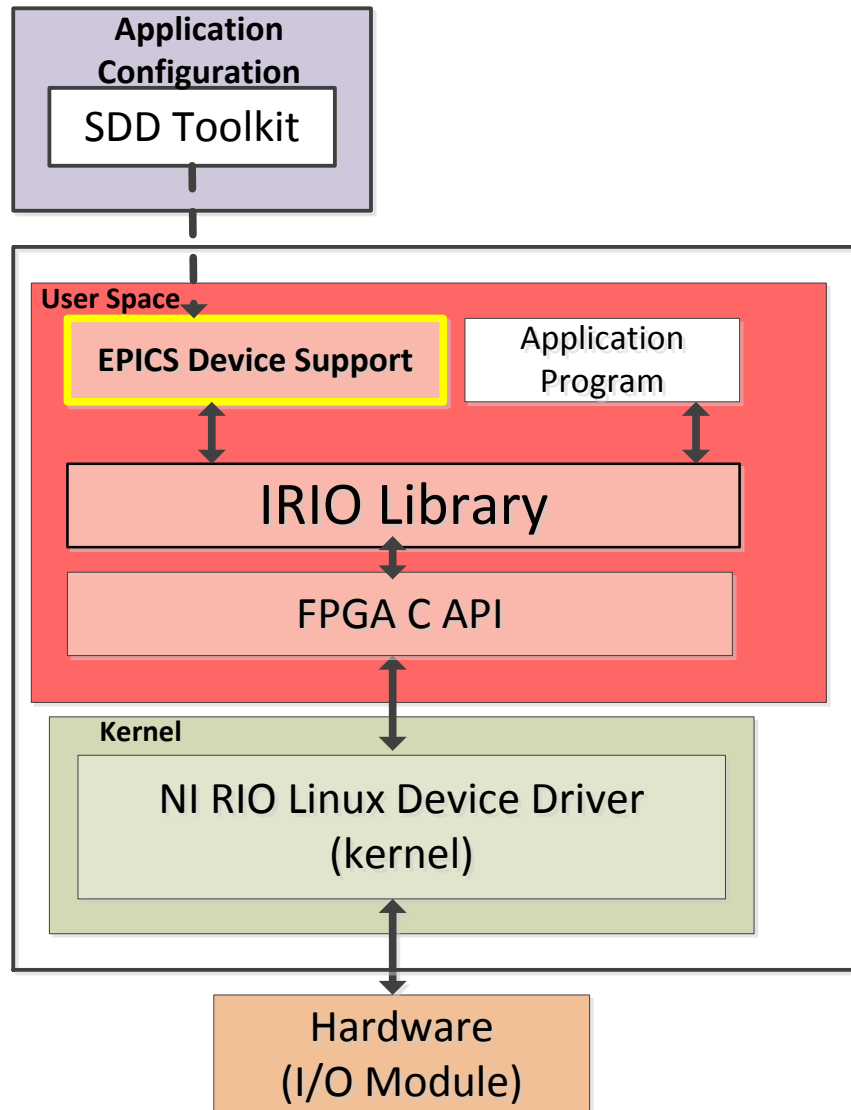
- Identification of the resources implemented in the FPGA
  - The Design Rules document describes the rules for the FPGA implementation
- Provides an API simplifying the interface with the FPGA.
  - Access to FPGA registers
  - Analog input
  - Digital I/O
  - DMA acquisition
  - Image acquisition using cameraink
    - Serial line for camera configuration
  - Signal Generation (DDS)



# IRIO resources mapping

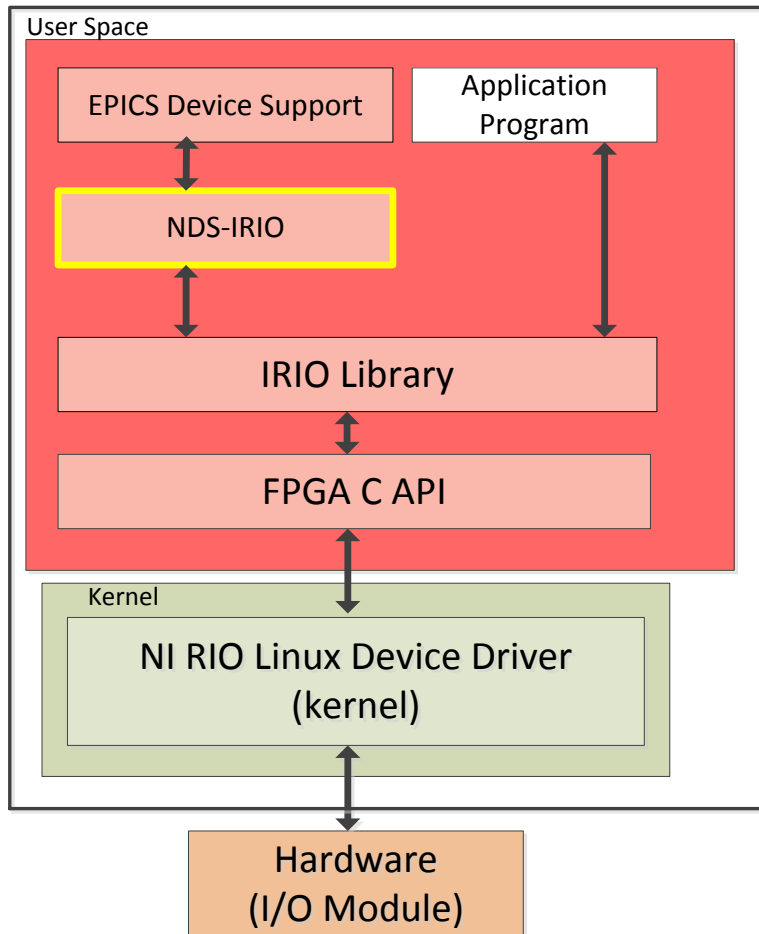


# IRIO Project: EPICS driver using asynDriver



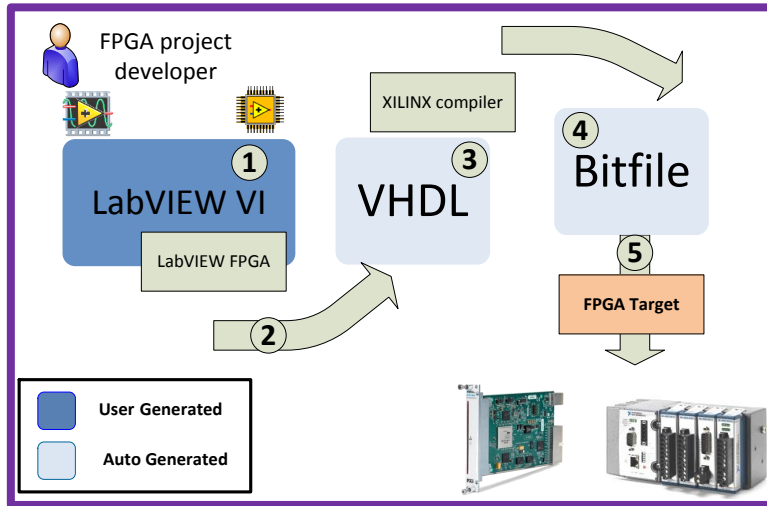
- ✓ EPICS device driver using **asynDriver** implementation for RIO devices (FlexRIO and cRIO) using IRIO library
  - ✓ Automatically connects the PVs with FPGA resources using IRIO library
- ✓ **If the user changes the FPGA design no compilation is needed**
- ✓ ITER SDD generates the complete software unit

# IRIO Project: C++ classes for Nominal Device Support

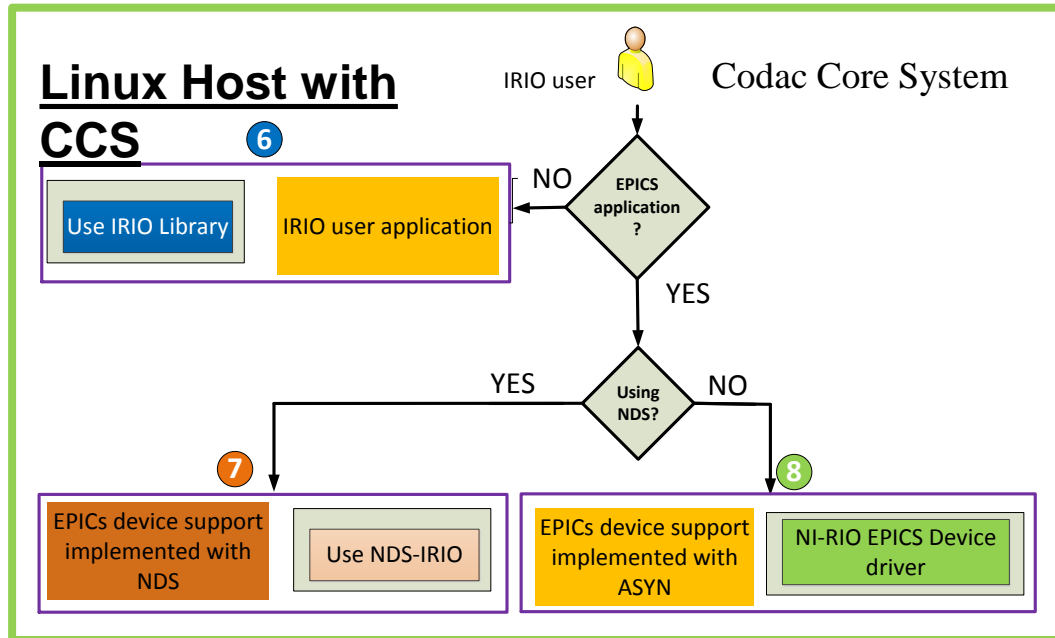
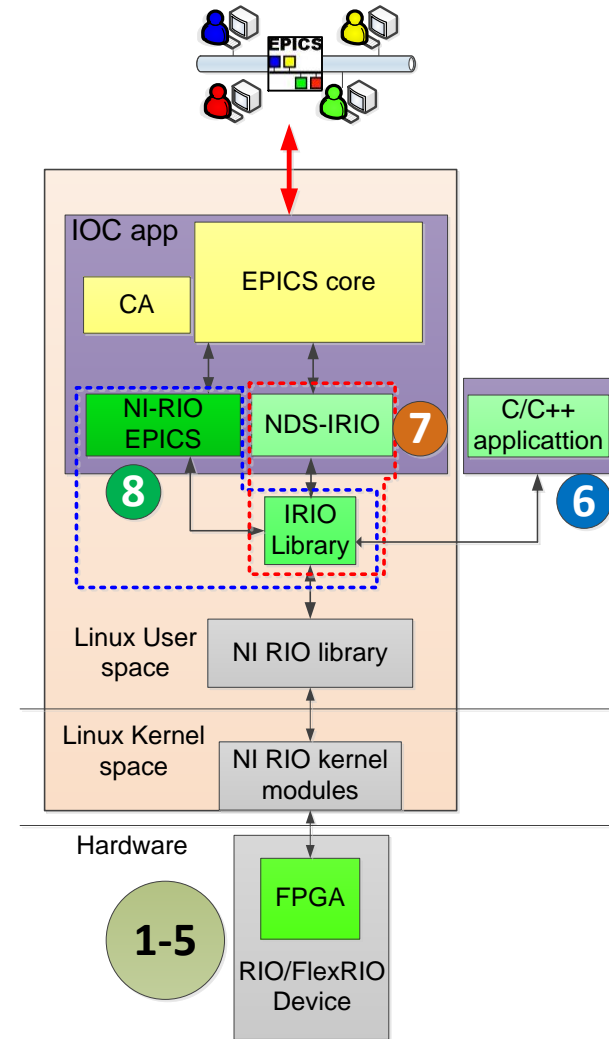


- Nominal Device Support approach defines a set of classes and PVs to be used for EPICS driver implementation.
- NDS-irio is the set of NDS extended classes to use FlexRIO devices
- Simplify the implementation of EPICS device support for FlexRIO using NDS

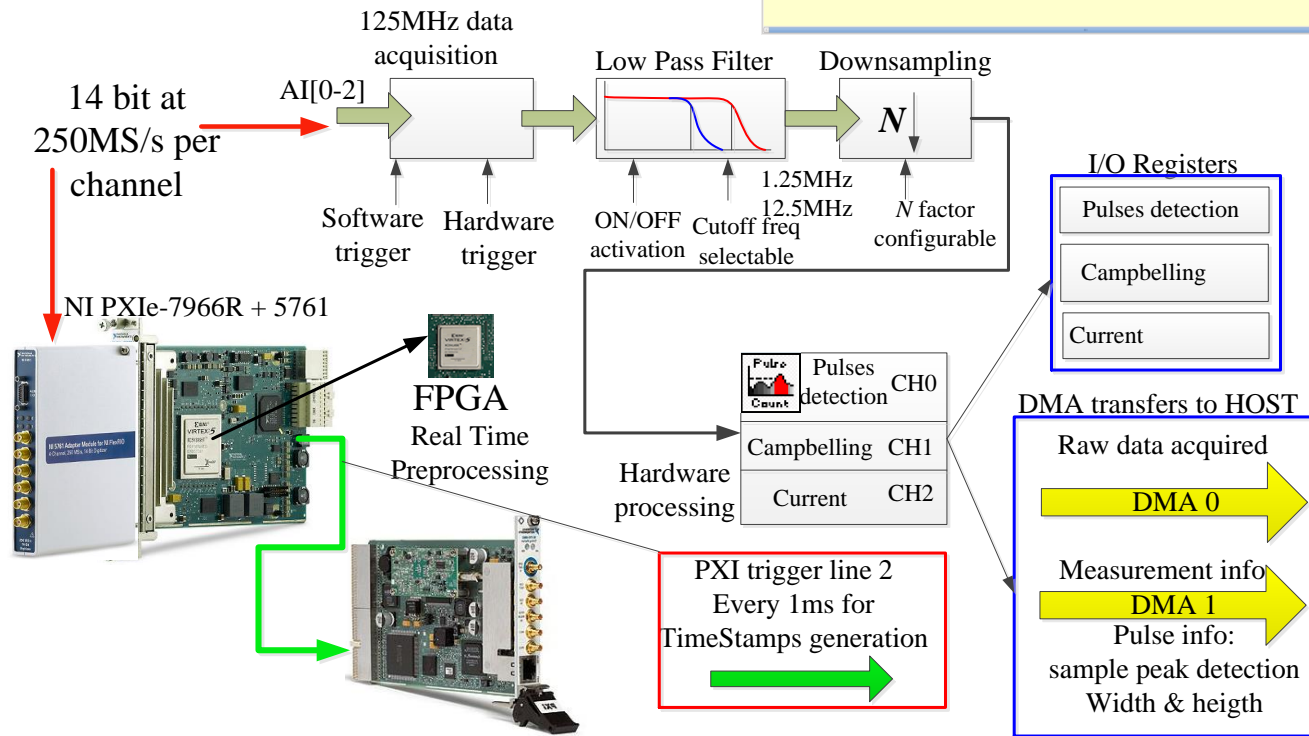
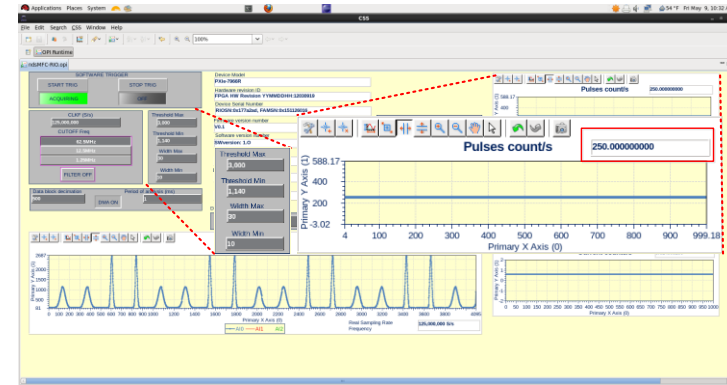
# Design Methodology



## Windows Host



- Integrate deterministic diagnostic into the FPGA (4 ADC sampling at 125MS/s).  
Data processing to detect/count pulses, RMS, and campbelling



PICMG  
Fast Controller  
(fc18-3)



EoSens 3CL

Can we add more processing capabilities?  
Is it possible to add a GPU?



The screenshot displays the EoSens CL software interface. At the top left is a grayscale camera feed with X and Y axes. To its right is the 'ACTUAL SETTINGS' panel with fields for Origin X, Origin Y, Width, Height, Resolution, spp, FPS, and FPN. Below the camera feed are several control panels: 'EoSens CL messaging CTRL' for TxUart and RxUart messages; 'IMAQ START/STOP' with ON/OFF buttons; 'DEVICE CONTROL' with ON/OFF buttons and a code field; 'CH GROUP CTRL' with START and PROCESSING buttons; 'IMAGE CH CTRL' with START and PROCESSING buttons and a channel selection field; 'ROI settings' with Origin X/Y, Width, Height, and a LOAD Conf button; and 'FPS' and 'Black level' settings. Blue callout bubbles point to the camera feed (labeled 'Image'), the 'ACTUAL SETTINGS' panel (labeled 'Readback'), the 'DEVICE CONTROL' panel (labeled 'Device PVs'), the 'CH GROUP CTRL' panel (labeled 'Channel PVs'), and the 'ROI settings' panel (labeled 'Setup').



# Conclusions

- We have defined a design methodology for implementing advanced data and image acquisition applications with RIO/FlexRIO devices, integrated with EPICS using IRIO software
- We have developed different LabVIEW/FPGA patterns and libraries for RIO devices
- It is not necessary to rewrite or even recompile the EPICS device support for every cRIO/FlexRIO configuration
- IRIO tools integrated in **ITER** CODAC Core System V5.2 (February 2016)
- IRIO tools are GPLv2
- Current users of IRIO:
  - ITER Diagnostics use cases, KSTAR project, Russian DA (cRIO)
  - ESS Bilbao





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**Thank you very much for your attention!!  
questions?**



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